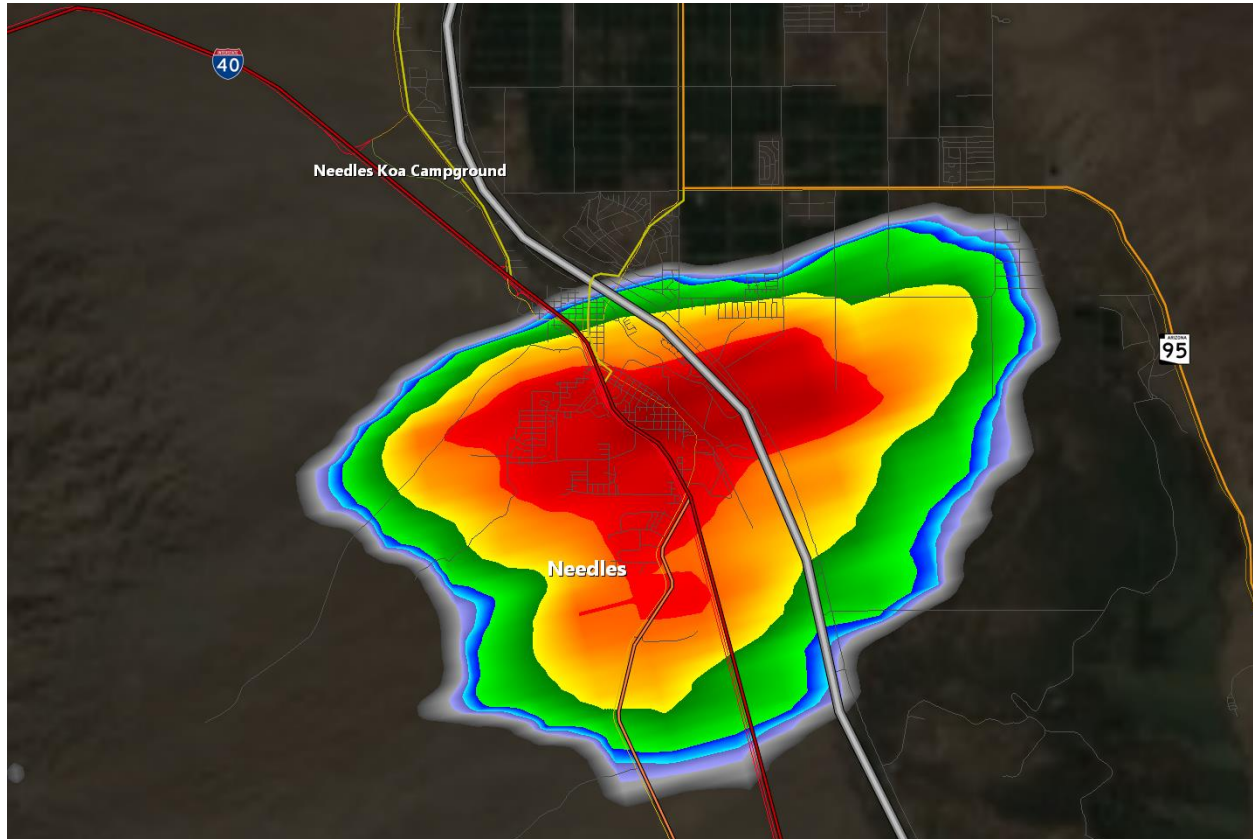


# 12 August 2014 Needles, CA

## Microburst and Flash Flooding

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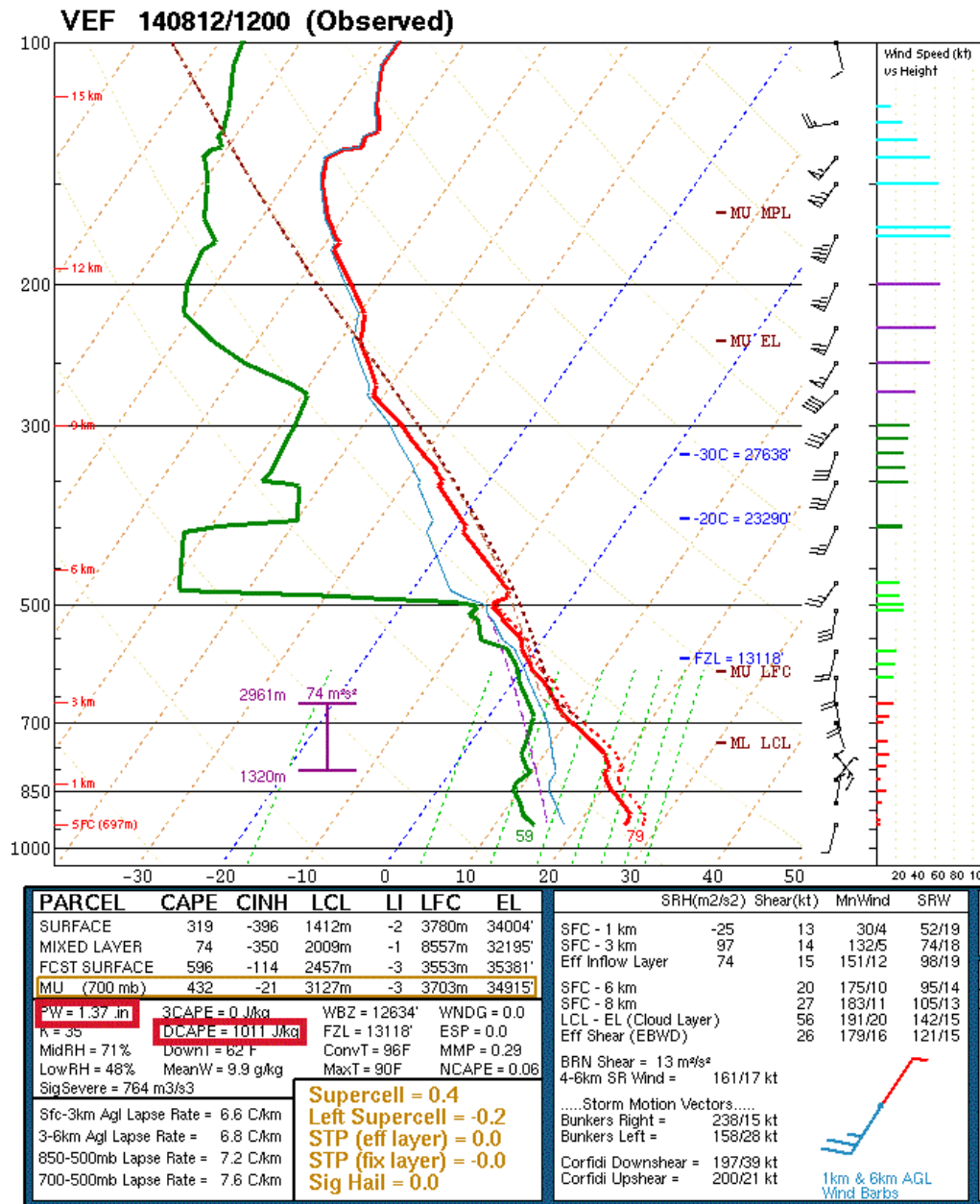


Radar image from the KESX Radar (0.5 degree elevation) of the storm that produced a microburst over downtown Needles, CA.

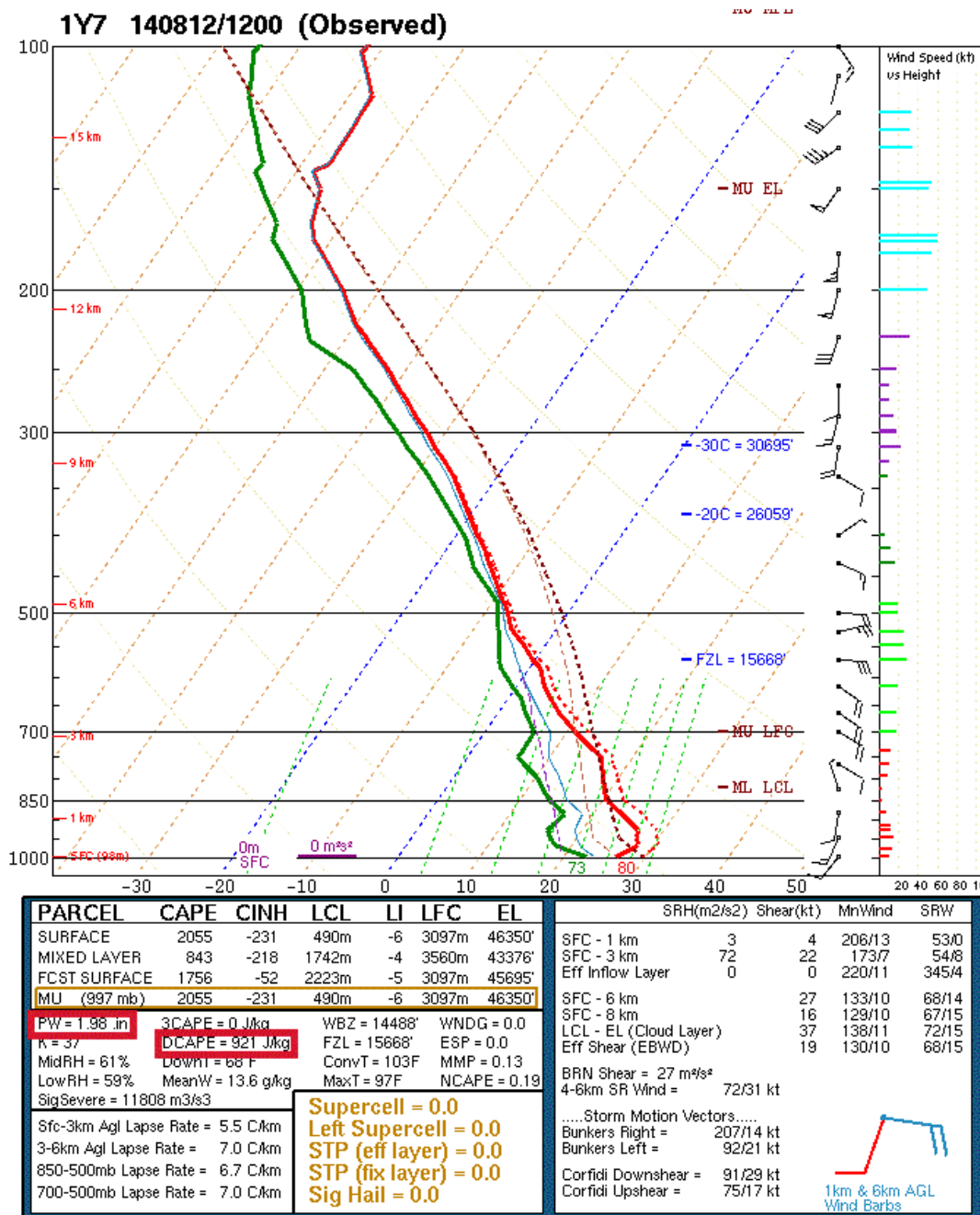
### Introduction & Setup

Thunderstorms developed over eastern San Bernardino and western Mohave counties on the afternoon and evening of August 12, 2014 and affected Needles, California with a microburst and significant flash flooding. A moist airmass was in place in the eastern two-thirds of the Las Vegas County Warning Area (CWA), with precipitable water values in Needles reaching 1.53 inches that morning. Precipitable water (PW) is a measure of the depth of liquid water at the surface that would result after precipitating all of the water vapor in a vertical column over a given location, typically extending from the surface to 300 mb. PW values exceeding 1.50 inches in the Desert Southwest are considered well above normal. The moist airmass was the result of high pressure to the east and an approaching low to the west pulling moisture up from the Gulf of California. The morning analysis showed an inverted trough rotating around the high over south-central Arizona and dry air filtering into the area at mid-levels from the west which

provided sufficient lift and instability for thunderstorm development across the area. This environment coupled with sufficient shear aloft raised concern for a marginal high wind/hail threat from microbursts with any storms that developed in this area. By the end of this day, 23 total warnings were issued by the office, with four (three flash flood and one severe) of them issued for the Needles area.



**Figure 1a.** Las Vegas sounding from 12Z (5 am) Tuesday, August 12, 2014. The PW values between Las Vegas and Yuma, AZ (Fig. 1b) show a south to north moisture gradient, with Las Vegas being on the edge of deeper moisture. DCAPE values were high at Las Vegas (> 1000 J/kg). However, lower dewpoints at Las Vegas allowed temperatures to warm much more than Yuma, thus creating a larger temperature-dewpoint spread (dewpoint depression), which contributes to effective downward momentum and results in strong surface winds.

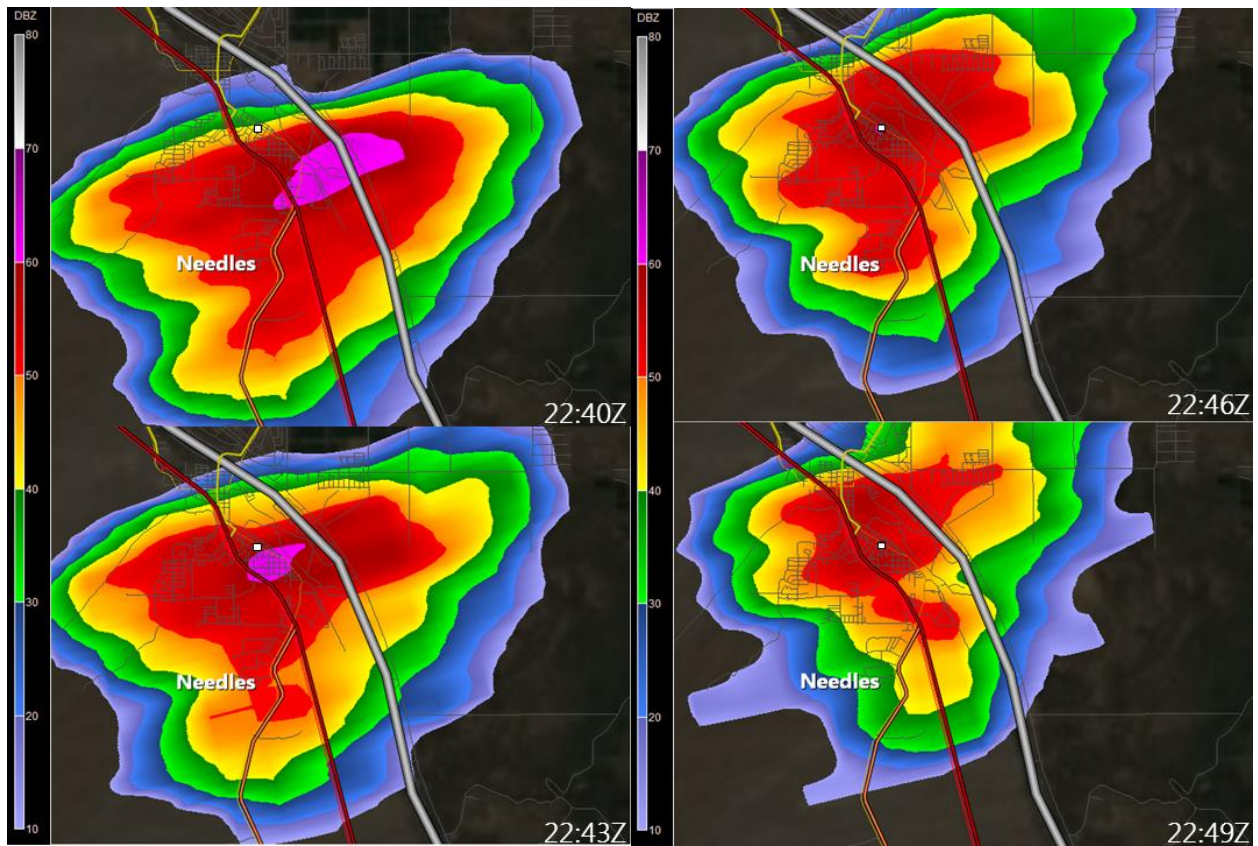


**Figure 1b.** Yuma, AZ sounding from 12Z (5 am) Tuesday, August 12, 2014. The PW values at this location show deep moisture over the area. DCAPE values at Yuma are at decent levels (typically values > 800 J/kg are decent). However, the temperature-dewpoint spread (dewpoint depression) is smaller than that at Las Vegas, resulting in less effective downward momentum within thunderstorm downdrafts.

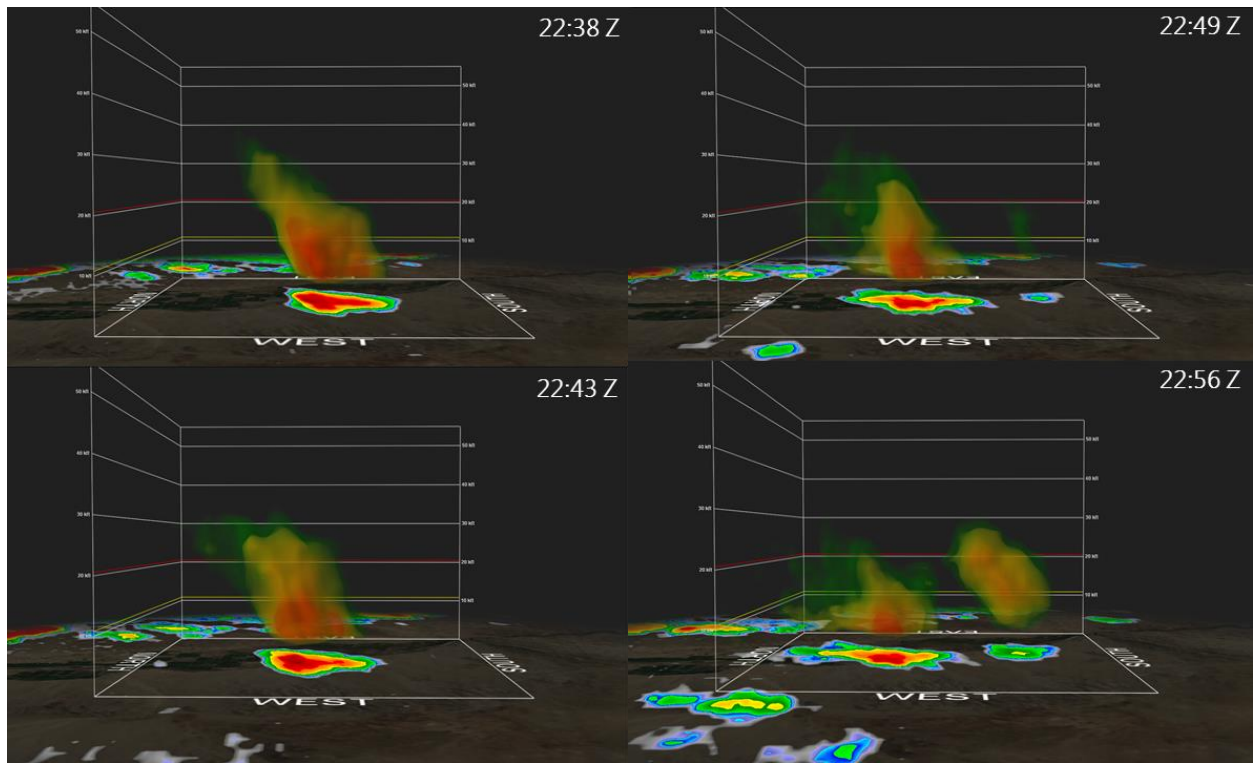
## The Event

Thunderstorms developed across northeastern portions of San Bernardino County as early as 12 pm, with storms increasing in coverage by 3 pm across eastern San Bernardino County, CA, as well as southern and western Mohave County, AZ. The first storm (hereafter referred to as storm one) to affect Needles developed along I-40 and US-95 just after 3:15 pm (22:15Z). This storm rapidly intensified as it moved north-northwest toward the center part of town, reaching peak intensity around 3:40 pm. The four radar scans from 3:40 pm to 3:49 pm (Fig. 2) showed the storm's strength drop off significantly along Broadway Street in the center part of Needles. Cross section and 3D data (Fig. 3) of the storm showed the core "collapse" from 3:40 pm through 3:50 pm, with the storm reduced to a shower by 4 pm. Subsequently, the first reports of damage were made at 3:49 pm, and other reports trickled in over the course of the next hour, with damage ranging from roofs blown off, to power lines and trees blown over. While a 59 mph wind gust was recorded by a weather station in northern Needles, wind speeds associated with this storm were estimated at between 75-80 mph in central portions of the town during the post storm damage survey. A second storm (hereafter referred to as storm two) formed just south of Needles featuring a much stronger core on radar (Figure 4a-b). This storm moved into Needles as well, with the core collapsing over town. However, storm two did not produce the same magnitude winds as the first storm did, due to the moistening of lower levels and cooling in surface temperature from the downdraft of the first storm. This reduced the microburst potential from subsequent storms (due to the reduction of DCAPE), making them solely heavy rain threats. Flash flooding became an issue when multiple storms formed in the wake of storms one and two and trained over Needles and surrounding areas. While DCAPE (Downdraft Convective Available Potential Energy) was focused on in this case, the main tool used by meteorologists to measure atmospheric instability is CAPE (Convective Available Potential Energy), which is a measure of buoyancy in the atmosphere. DCAPE is a subset of CAPE. It estimates the potential strength of downdrafts in thunderstorms which makes it a useful tool for forecasting microburst potential (Fig. 1a & 1b). The state of the environment after storm one would be comparable to Yuma's 18Z sounding (Fig. 1b), due to the fact that it featured less instability and greater moisture depth, as opposed to the 12Z soundings from Yuma and Las Vegas. The Needles, CA atmospheric profile would have undergone similar changes following storm one, which mitigated the microburst potential of subsequent storms that affected the area.

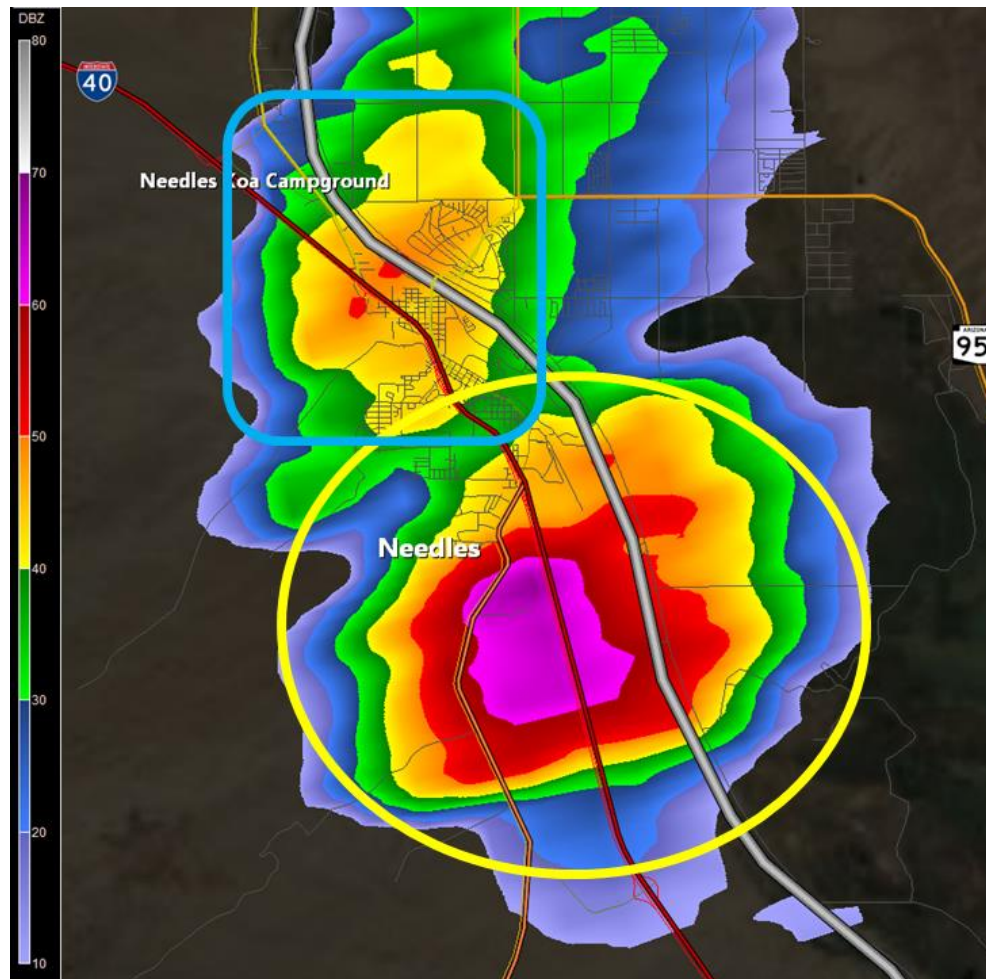




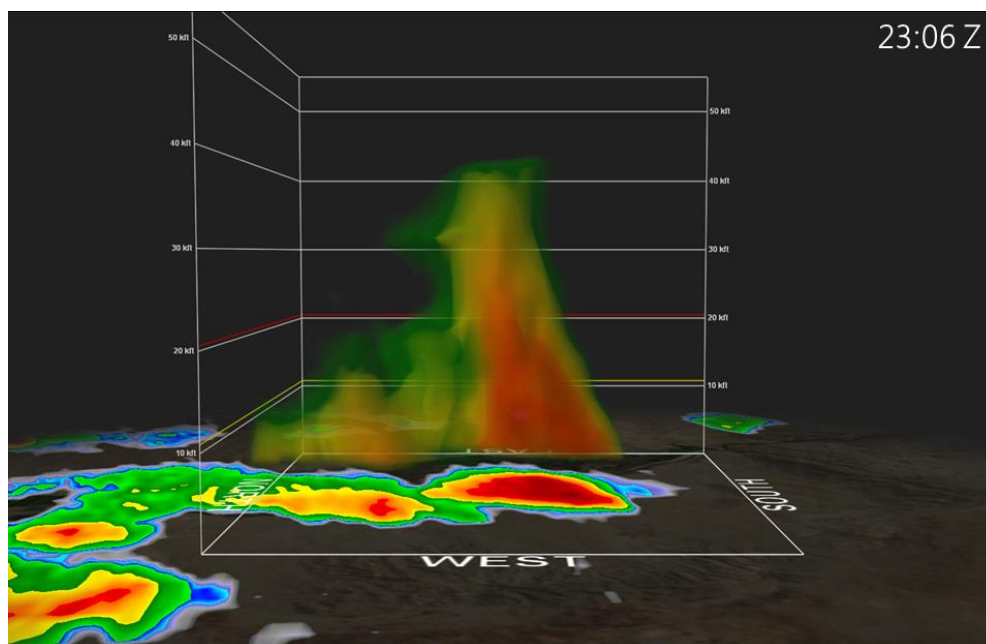
**Figure 2.** Time series of storm one using KESX base reflectivity. The small white box east of I-40 (red line) is the approximate location of the Burger Hut for reference. Notice the storm reached peak intensity (~65 dBZ) at 22:43Z, just southwest of that location. The subsequent two scans show this core maxima disappearing over the red box as the core collapses.



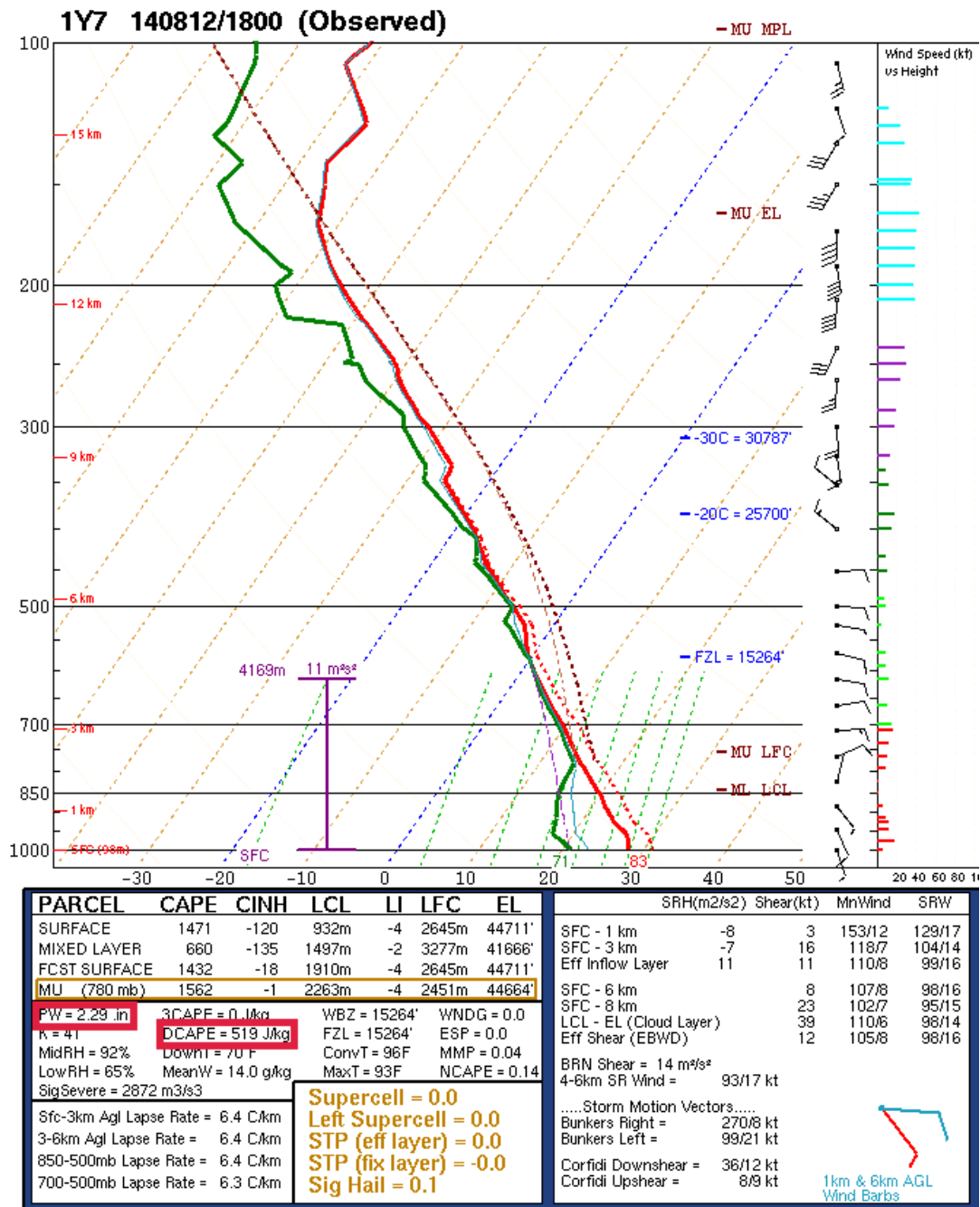
**Figure 3.** Time series of the 3D structure of storm one using the Volume Explorer tool in GR Analyst. Most of the structure was made semi-transparent to allow for the investigation of the core. Note the highest dBZ's shrinking from ~20,000 ft (red line) in every 3D scan, until they are nearly non-existent by 22:56Z. Notice the formation of storm two from 22:49Z to 22:56Z as storm one weakens significantly.



**Figure 4a.** Radar imagery of storm two (yellow circle) at peak intensity as it moves northwestward into an area less conducive for microbursts due to storm one (blue square) modifying the environment. Note that this storm, as well as the storms other storms northwest of Needles at this time formed on the outflow of storm one. Radar image taken at 23:06Z (4:06 PM).



**Figure 4b.** 3D structure of storm two. Compared to the 3D structure of storm one illustrated in Figure 3, this storm is much stronger, with tops exceeding 40,000 feet and the highest dBZ's breaking 30,000 feet. Despite this, no new reports of severe wind or damage were received in the wake of this storm.



**Figure 4c.** Yuma, AZ sounding from 18Z (11 am) Tuesday, August 12, 2014. Showers and thunderstorms were occurring in the area at the time of the observation, leading to higher PW and lower DCAPE values.

## Impacts

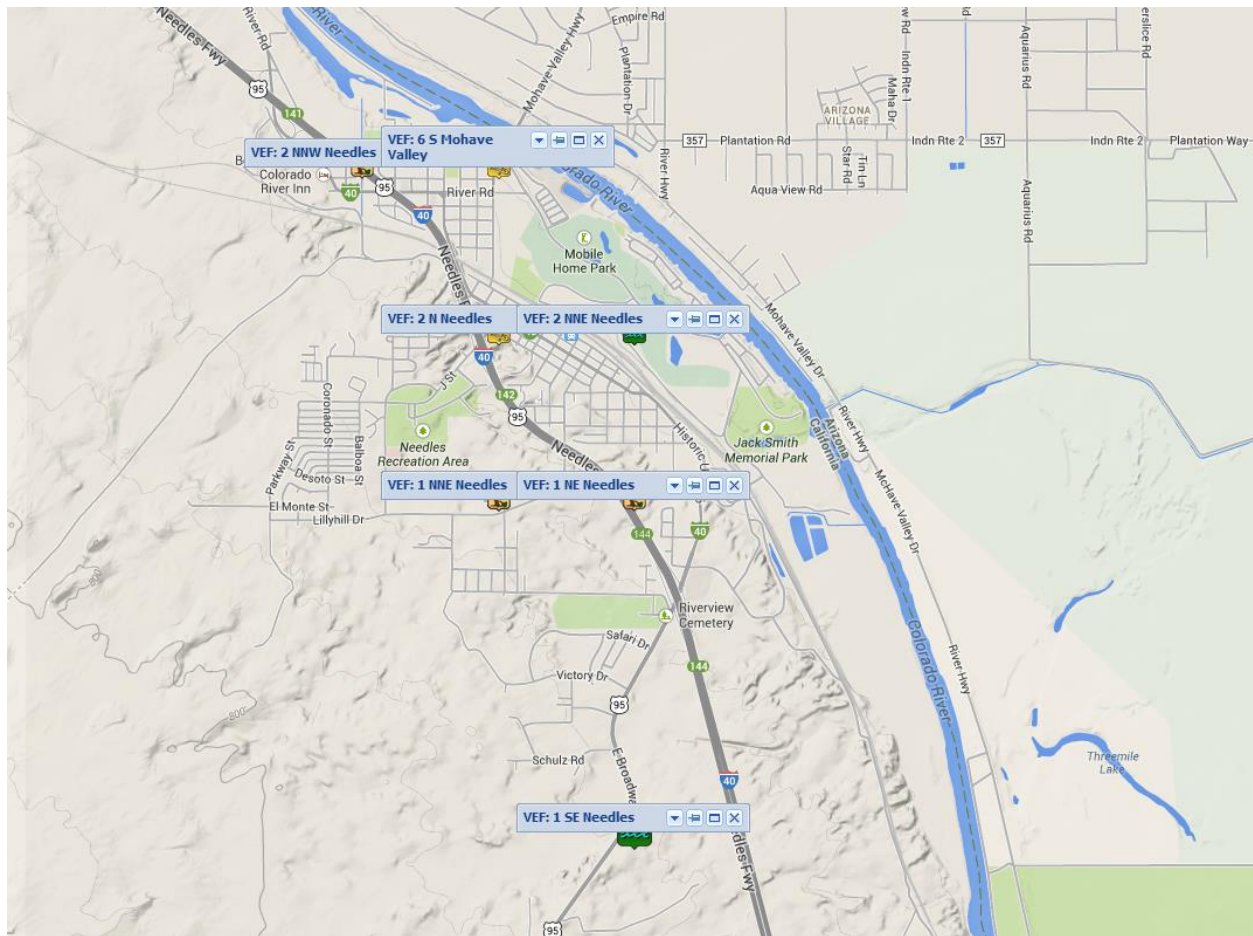
The bulk of the heavy damage from the downburst was located on the northeast side of I-40, in the Broadway Street/Route 66 area. While winds reached severe levels (>58 mph), the severity of damage was exacerbated by the building structures and age. For example, the 57 year-old Burger Hut building had a porch on its western facing side, making the roof susceptible to strong surface winds from this direction. The damage survey showed the roof was “peeled” back from the porch area. The same was the case at Lucy’s Mexican restaurant with an awning over the entrance and an apartment building’s second floor walkway (see Picture 2 and 3). The trees that were blown over throughout the town exhibited shallow root systems, which are common in the Desert Southwest, making them prone to high winds. Outside of downtown Needles, much of the damage noted was missing shingles from homes, downed power lines, and flash flooding damage in and around washes.

Officially, the Needles ASOS station (KEED) recorded 1.80 inches of rainfall from showers and thunderstorms observed later in the evening. The microburst observed earlier in the afternoon knocked the power out at the station (Table 1); therefore no precipitation measurements were made from 4 pm-6 pm (23Z-01Z). In that timeframe, two additional thunderstorms moved through the Needles area, yielding rainfall at intense rates. An effort was made during this post analysis to find third party precipitation measurements from efforts such as CoCoRaHS (Community Collaborative Rain, Hail and Snow Network), but no additional data was found. Other radar parameters were observed during this timeframe and showed intense rainfall over Needles from storm one and two. All four storms observed during this timeframe produced significant rainfall over rural areas south of Needles, leading to flooding in washes. Approximately 7 miles south of Needles, portions of 5 Mile Road were washed out by flowing water as a result of intense rainfall in a short time span. Though only storm one and two produced high rainfall rates over Needles during this timeframe, the intense rainfall rates produced by these storms were enough to cause washes to flow in the area, as there were flash flooding reports in the city limits prior to the additional 1.80 inches of rainfall later in the evening. The additional rainfall prompted more flash flooding in the area, and even a swift water rescue approximately one mile south of the city limits that evening.



Time (PDT)	Temp.	Dew Point	Humidity	Pressure	Visibility	Wind Dir.	Wind Speed	Gust Speed	Precip	Conditions
2:56 PM	105.1 F	59.0 F	22%	29.71 in	10.0 mi	SSE	15.0 mph	23.0 mph	N/A	Scattered Clouds
3:59 PM	M	M	M	29.80 in	M	N	M	M	M	Thunderstorm
6:56 PM	93 F	71.1 F	49%	29.71 in	M	ENE	5.8 mph	N/A	N/A	Thunderstorm
7:14 PM	91.9 F	72.0 F	52%	29.82 in	10.0 mi	NNE	5.8 mph	N/A	N/A	Thunderstorm
7:38 PM	84 F	69.1 F	61%	29.85 in	10.0 mi	ESE	13.8 mph	29.9 mph	N/A	Overcast
7:56 PM	82.9 F	68.0 F	60%	29.78 in	10.0 mi	SSE	13.8 mph	N/A	N/A	Thunderstorm
8:47 PM	78.1 F	70.0 F	76%	29.92 in	10.0 mi	NNW	21.9 mph	28.8 mph	0.03 in	Lt T-storms & Rain
8:56 PM	79 F	66.9 F	66%	29.84 in	10.0 mi	N	20.7 mph	31.1 mph	0.05 in	T-storms & Rain
9:10 PM	75.9 F	68.0 F	76%	29.96 in	1.8 mi	N	11.5 mph	N/A	0.29 in	Hvy T-storms & Rain
9:19 PM	73.9 F	70.0 F	87%	29.96 in	1.0 mi	N	15.0 mph	N/A	0.72 in	Hvy T-storms & Rain
9:56 PM	75.9 F	71.1 F	85%	29.90 in	3.0 mi	SW	16.1 mph	N/A	1.66 in	Hvy T-storms & Rain
10:56 PM	78.1 F	69.1 F	74%	29.83 in	10.0 mi	S	17.3 mph	N/A	0.09 in	Light Rain
11:56 PM	81 F	68.0 F	62%	29.85 in	10.0 mi	N	M	N/A	0.00 in	Overcast

**Table 1.** Table of the observations from mid-afternoon through the evening of 12 August 2014 at KEED. Notice the missing data at 3:59 pm followed by the two hour gap in reports due to a power outage following the first storm. Two other storms formed south of the area and moved through, yielding heavy rainfall in a short period of time. Rainfall ceased at KEED around 5:30 pm (00:30Z) before additional showers and storms yielded 1.80 inches of rainfall in roughly a two hour period, with 1.66 inches falling in roughly an hour (9 pm-10 pm). During that hour, 0.43 inches of rainfall fell in a 9 minute period (9:10 pm-9:19 pm), with an additional 1.23 inches falling in the following 37 minutes. Obs courtesy of Weather Underground.



**Figure 6.** Map of LSR (Local Storm Report's) locations from wind damage and flooding events that occurred with the storms on the afternoon and evening of 12 August 2014 in the Needles, CA area.

Report Time	County	Location	ST	Event Type	Source	Event Description
Tue Aug 12 2014 22:48:00 GMT-0700 (Pacific Daylight Time)	San Bernardino	2 N Needles	CA	TSTM WND DMG	BROADCAST MEDIA	MEDIA REPORTS SEVERAL LARGE TREES DOWN IN FRONT OF NEEDLES FOUR SEASONS NURSERY.
Tue Aug 12 2014 22:48:00 GMT-0700 (Pacific Daylight Time)	San Bernardino	2 NNE Needles	CA	TSTM WND DMG	PUBLIC	PUBLIC REPORTS ROOF OF BURGER HUT ALONG BROADWAY IN NEEDLES HAS BLOWN OFF. OTHER SOURCES AND PICTURES CONFIRM...TIME ESTIMATED BY SEVERAL REPORTS. INITIAL REPORT VIA TWITTER
Tue Aug 12 2014 22:48:00 GMT-0700 (Pacific Daylight Time)	San Bernardino	2 NNE Needles	CA	TSTM WND DMG	BROADCAST MEDIA	MEDIA REPORTS SHEET METAL ROOF BLOWN OFF OF LUCYS MEXICAN RESTAURANT AND ACROSS THE STREET
Tue Aug 12 2014 22:48:00 GMT-0700 (Pacific Daylight Time)	San Bernardino	2 NNE Needles	CA	TSTM WND DMG	BROADCAST MEDIA	SEVERAL REPORTS FROM MEDIA AND SPOTTERS OF DAMAGE TO AT LEAST 50 POWER POLES IN THE GREATER NEEDLES AREA DUE TO THUNDERSTORM WINDS.
Tue Aug 12 2014 22:48:00 GMT-0700 (Pacific Daylight Time)	San Bernardino	1 NNE Needles	CA	TSTM WND DMG	BROADCAST MEDIA	MEDIA AND TRAINED SPOTTERS REPORT SEVERAL HOMES WITH SHINGLES BLOWN OFF IN THE VICINITY OF CIBOLA AND D STREETS IN NEEDLES.
Tue Aug 12 2014 22:48:00 GMT-0700 (Pacific Daylight Time)	San Bernardino	2 N Needles	CA	NON-TSTM WND DMG	BROADCAST MEDIA	MEDIA REPORTS SEVERAL LARGE TREES DOWN IN FRONT OF NEEDLES FOUR SEASONS NURSERY
Tue Aug 12 2014 22:50:00 GMT-0700 (Pacific Daylight Time)	Mohave	2 NNE Needles	AZ	TSTM WND DMG	NEWSPAPER	NUMEROUS TREES WERE REPORTED DOWN IN NEEDLES, ESPECIALLY NEAR THE GOLF COURSE. SEVERAL METAL FENCES WERE BLOWN DOWN AND A PORTION OF BILLBOARD WAS SHREDDED. MOST OF THE CITY LOST POWER FOR SEVERAL HOURS.
Tue Aug 12 2014 22:50:00 GMT-0700 (Pacific Daylight Time)	San Bernardino	2 NNW Needles	CA	TSTM WND DMG	NEWSPAPER	*** 1 INJ *** 1 PERSON WAS INJURED BY FALLING DEBRIS WHEN A PORTION OF THE CEILING COLLAPSED AT THE NEEDLES INN.
Tue Aug 12 2014 22:57:00 GMT-0700 (Pacific Daylight Time)	Mohave	6 S Mohave Valley	AZ	TSTM WND GST	MESONET	59 MPH WIND GUST MEASURED.
Tue Aug 12 2014 23:00:00 GMT-0700 (Pacific Daylight Time)	San Bernardino	2 NNE Needles	CA	FLASH FLOOD	TRAINED SPOTTER	AT LEAST 6 INCHES OF WATER WERE FLOWING ACROSS BROADWAY IN NEEDLES.
Tue Aug 12 2014 23:00:00 GMT-0700 (Pacific Daylight Time)	San Bernardino	1 NNE Needles	CA	TSTM WND DMG	TRAINED SPOTTER	THUNDERSTORM WINDS DAMAGED SEVERAL ROOFS ON HOMES IN NEEDLES. ONE LARGE TREE WAS REPORTED DOWN AS WELL.
Tue Aug 12 2014 23:26:00 GMT-0700 (Pacific Daylight Time)	San Bernardino	1 NE Needles	CA	TSTM WND DMG	PUBLIC	SPOTTER REPORTS SIGNS AND SOME TELEPHONE POLES BLOWN OVER WITH HEAVY PONDING ON FREEWAY EXIT AND SURROUNDING STREETS
Wed Aug 13 2014 05:03:00 GMT-0700 (Pacific Daylight Time)	San Bernardino	1 SE Needles	CA	FLASH FLOOD	PUBLIC	PUBLIC REPORTS SAN BERNARDINO COUNTY FIRE CONDUCTING SWIFT WATER RESCUE ALONG US 95 AT MM56. VIA TWITTER.

**Table 2.** Table of LSR (Local Storm Report's) details from wind damage and flooding events that occurred with the storms on the afternoon and evening of 12 August 2014 in the Needles, CA area.

## Damage Pictures



**Picture 1.** A before and after photo of the Burger Hut in downtown Needles, CA. The before picture is courtesy of Google Images, and the after photo was taken on the damage survey by Dan Berc of NWS Las Vegas.



**Picture 2.** A before and after shot Lucy's Mexican Restaurant in downtown Needles, CA. The before photo is courtesy of Google Images, and the after photo is courtesy of Discover Needles, California Facebook page.





**Picture 3.** Picture collage of downed trees around Needles. Note the shallow root systems, which are common in the Desert Southwest. This makes trees more susceptible to high winds. The photo collage is courtesy of Discover Needles, California Facebook page.



**Picture 4.** Picture of an apartment balcony flipped over on its roof. The photo was taken on the damage survey by Dan Berc of NWS Las Vegas.



**Picture 5.** Picture of a cinder block wall blown down by the wind in Downtown Needles. The photo was taken on the damage survey by Dan Berc of NWS Las Vegas.



**Picture 6.** Picture of the aftermath of flash flooding in a wash beneath BNSF railroad track in Needles, CA. The photo was taken on the damage survey by Dan Berc of NWS Las Vegas.